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Sir:

With reference to the filing in the United States Patent and Trademark Office of an application for patent in the name(s) of:

Takayuki NAKAJIMA, Hideo TAKECHI

entitled:

# IMAGE PICKUP APPARATUS AND IMAGE PICKUP METHOD

The following are enclosed:

X Specification ( 14 pages)

X 10 Sheet(s) of Drawings

X 10 Claim(s) (including 2 independent claim(s)

X Our check for \$ 730.00, calculated on the basis of the claims as amended by any enclosed preliminary amendment as follows:

Basic Fee, \$690.00 (\$345.00)	\$ 690.00
Number of Claims in excess of 20 at \$18.00 (\$9.00) each:	-0-
Number of Independent Claims in excess of 3 at \$78.00 (\$39.00) each:	-0-
Multiple Dependent Claim Fee at \$260.00 (\$130.00)	-0-
Total Filing Fee	\$ 690.00
X Assignment Recording Fee \$40.00	\$ 40.00

X Oath or Declaration and Power of Attorney  
X New X signed    unsigned  
   Copy from a prior application (37 C.F.R. 1.63(d))

X Certified copy of each of the following application(s) to substantiate the claim(s) for priority made in the Declaration:

Application No. Filed In

11-258101 10 September 1999 Japan

Please charge any additional fees required for the filing of this application or credit any overpayment to Deposit Account No. 50-0320.

Respectfully submitted,

FROMMER LAWRENCE & HAUG LLP  
Attorneys for Applicants

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William S. Fromme  
Req. No. 25,506

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PATENT  
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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE  
APPLICATION FOR LETTERS PATENT

09652046-0960800  
TITLE: IMAGE PICKUP APPARATUS AND IMAGE PICKUP  
METHOD  
INVENTORS: Takayuki NAKAJIMA, Hideo TAKECHI

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## SPECIFICATION

## TITLE OF THE INVENTION

## IMAGE PICKUP APPARATUS AND IMAGE PICKUP METHOD

## BACKGROUND OF THE INVENTION

## [Technical Field]

The present invention relates to an image pickup apparatus. More particularly, the present invention relates to an image pickup apparatus which is applied to a video camera using a complementary mosaic color coding CCD.

## [Prior Art]

A single-board CCD color camera system or the like captures color images by using a single solid-state image pickup element such as a CCD image sensor. Such a system needs to provide each pixel with a different color filter namely a color coding filter on the CCD image sensor as an image pickup element.

FIG. 1 shows an example of a color array structure used for the complementary mosaic color coding filter as an example of a color coding filter. In this figure, Cy stands for cyan, Ye for yellow, G for green, and Mg for magenta. There are lines N0 to N5. The ith line is indicated as Ni ( $0 \leq i$ ). Each pixel is expressed as the jth pixel ( $0 \leq j$ ). According to this convention,  $X_{ij}$  means color X for the jth pixel on line Ni. For example, G12 means color G (green) for the second pixel on line N1. An example in FIG. 3 shows that colors are repeated horizontally at a 2-pixel interval such as Cy, Ye, Cy, Ye, and so on. Colors are repeated vertically at a 4-pixel (4-line) interval such

as Cy, G, Cy, Mg, and so on. Namely, this example uses a 2-pixel interval for horizontal repetition and a 4-line interval for vertical repetition.

FIG. 2 is a block diagram of a camera signal processing system for a video camera apparatus as an image pickup apparatus. This system is provided with a CCD image sensor 102 which uses such a complementary mosaic color coding filter as illustrated in FIG. 1 or 3.

In FIG. 2, an image pickup signal from an optical system 101 is sensed in a CCD image sensor 102 and is sent to a delay circuit 120 via a front end circuit 103. The optical system 101 comprises a camera lens, a mechanical shutter, and the like. The CCD image sensor 102 functions as an image pickup element. The front end circuit 103 comprises a CDS (correlation double sampling) circuit, a GCA (gain control amplifier), an A/D (analog/digital) converter, and the like. The CCD image sensor 102 is supplied with a pulse signal read from a timing generator 106. The front end circuit 103 is supplied with a sampling pulse, an A/D converter drive pulse, and the like from the timing generator 106. The timing generator 106 is supplied with a control signal from a system control circuit 107. The delay circuit 120 is also supplied with a control signal from the system control circuit 107. An output signal from the delay circuit 120 is sent to a Y (brightness) process circuit 140 and a C (chromaticness) process circuit 160 via a preprocessing circuit 130. The Y process circuit 140 and the C process circuit 160 are also provided with a control signal from the system control circuit 107.

The system in FIG. 2 reads fields from the interlaced scanning CCD. As shown in FIG. 3, the system adds vertically adjacent pixel data to each other on every two lines in the CCD. The system reads this data in the form of a signal as illustrated in FIG. 4. This operation is called 2-line mixed reading. When the system reads every two lines N0+N1, N2+N3, and so on for one field by mixing and adding, the system then reads every two lines N1+N2, N3+N4, and so on for the next field by mixing and adding. For each pixel to be mixed and added, Cy+G is expressed as S1r, Ye+Mg as S2r, Cy+Mg as S1b, and Ye+G as S2b.

FIG. 5 shows chromaticness signal processing including the C process circuit 160 in FIG. 2 and peripheral circuits. In FIG. 5, the delay circuit 120 retrieves a no-delay signal [HH0D], a 1H delay signal [HH1D], and a 2H delay signal [HH2D] using two 1H (one horizontal interval or one line) delay devices 121 and 122. The delay circuit then sends these signals to the preprocessing circuit 130. In the preprocessing circuit 130, an adder 131 adds the above-mentioned signals [HH0D] to [HH2D]. A 1/2 multiplier 132 halves these signals like  $([HH0D]+[HH2D])/2$  and sends the processed signal to the C process circuit 160. The delay circuit sends the 1H delay signal [HH1D] unmodified to the C process circuit 160. This signal is used for processing. In the C process circuit 160, the 1H delay signal [HH1D] and the signal  $([HH0D]+[HH2D])/2$  are sent to the postprocessing circuit 162 via a horizontal spatial phase synchronization filter 161. An output is retrieved from the postprocessing circuit 162. The horizontal spatial phase synchronization filter 161 uses the tap factor

(1,0,3)/(3,0,1) for a filter operation. With respect to a signal for lines N2+N3 in FIG. 4, a filter operation using tap factors (1,0,3) signifies multiplying Cy20+Mg30 by the weight 1 and multiplying Cy22+Mg32 by the weight 3. (Additionally, there may be normalization through the use of division by a sum of factors.) Such a filter operation synchronizes horizontal spatial phases.

During the chromaticness signal processing in FIG. 5, delay lines of the delay circuit 120 synchronize vertical spatial phases for the signal [HH1D] and the signal ([HH0D]+[HH2D])/2. The horizontal spatial phase synchronization filter 161 synchronizes a horizontal spatial phase for each of these signals as S1 and S2. The postprocessing circuit 162 generates a chromaticness signal by processing signals S1r, S2r, S1b, and S2b whose vertical and horizontal spatial phases are synchronized.

The above-mentioned signals [HH1D] and ([HH0D]+[HH2D])/2 are expressed as follows with regard to pixel rates for the CCD image sensor 102.

$$[HH1D] = N2 + N3$$

$$([HH0D]+[HH2D])/2 = ((N0+N1)+(N4+N5))/2$$

A chromaticness signal is created at the CCD pixel rate based on data for six lines N0 to N5 in a vertical direction. Namely, the following filter operation is performed in a vertical direction according to filter tap factors.

$$(0,0,2,2,0,0)/(1,1,0,0,1,1)$$

A camera signal processing system according to the conventional field reading causes a problem during chromaticness processing. Specifically, given that "fsv"

signifies a sampling frequency for the CCD pixel rate in a vertical direction, the above-mentioned filtering in the vertical direction causes a problem of generating a false color at (1/4) fsv in the spatial frequency band.

#### BRIEF SUMMARY OF THE INVENTION

The present invention has been made in consideration of the foregoing. It is therefore an object of the present invention to provide an image pickup apparatus which can eliminate a false color at (1/4) fsv in the spatial frequency band during chromaticness signal processing.

For the purpose of solving the above-mentioned problem, an image pickup apparatus according to the present invention comprises: an image pickup element having a color coding filter; spatial phase synchronization means for synchronizing spatial phases in horizontal and vertical directions based on output from each line in the image pickup element; and synthesis means for generating a synthesized signal based on a signal from the spatial phase synchronization means, wherein this signal has a spatial phase synchronized horizontally and vertically. The image pickup apparatus according to the present invention processes chromaticness of signals from this synthesis means.

The color coding filter is a complementary mosaic color coding filter. This complementary mosaic color coding filter comprises: a first line which is an alternate repetition of Cy and Ye; a second line which is an alternate repetition of G and Mg; a third line which is an alternate repetition of Cy and Ye; and a fourth line which is an

alternate repetition of Mg and G. The complementary mosaic color coding filter is based on a repetition of two pixels horizontally by four lines vertically.

The spatial phase synchronization means generates a signal whose horizontal and vertical phases are synchronized. The synthesis means performs the following operations based on Cy (cyan), Ye (yellow), G (green), and Mg (magenta) in each pixel data for that signal.

$$S1r = Cy + G, \quad S2r = Ye + Mg$$

$$S1b = Cy + Mg, \quad S2b = Ye + G$$

These operations create new signals S1r, S2r, S1b, and S2b.

An image pickup apparatus according to the present invention comprises: an image pickup element having a color coding filter; spatial phase synchronization means for synchronizing horizontal and vertical spatial phases based on output from each line in the image pickup element; and synthesis means for generating a synthesized signal based on a signal from the spatial phase synchronization means, wherein this signal has a spatial phase synchronized horizontally and vertically. The image pickup apparatus according to the present invention can eliminate a false signal at (1/4) fsv in a chromaticness signal and greatly improve images by processing chromaticness of signals from this synthesis means.

#### BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWINGS

FIG. 1 shows an example of a complementary mosaic color coding filter on a CCD image sensor;

FIG. 2 is a block diagram showing an example of a camera signal processing system for a conventional video camera apparatus;

FIG. 3 illustrates 2-line mixed reading for the CCD image sensor;

FIG. 4 illustrates a CCD output signal generated by 2-line mixed reading of the CCD image sensor;

FIG. 5 is a block diagram showing part of a configuration associated with the conventional chromaticness signal processing;

FIG. 6 is a block diagram showing a configuration of a video camera apparatus to which an embodiment of the present invention is applied;

FIG. 7 is a block diagram showing part of a configuration associated with the chromaticness signal processing which is a major function for an embodiment of the present invention;

FIG. 8 illustrates frame reading on the CCD image sensor;

FIG. 9 illustrates a CCD output signal when two field signals are used to read all pixels from the CCD image sensor by interlaced scanning; and

FIG. 10 illustrates a signal after rearrangement according to a pixel array on the CCD image sensor with reference to the CCD output signaling FIG. 9.

#### DETAILED DESCRIPTION OF THE INVENTION

Embodiments of an image pickup apparatus according to the present invention will be described in detail, with reference to the accompanying drawings. FIG. 6 is a block diagram showing a system configuration of a video camera apparatus as the

embodiment of an image pickup apparatus according to the present invention. FIG. 7 is a block diagram showing part of a configuration associated with the chromaticness signal processing which is a major function for the embodiment of the present invention.

In FIG. 6, an optical system 11 in a camera comprises a lens, a mechanical shutter, and the like. A CCD image sensor 12, functioning as an image pickup element, picks up and photoelectrically converts an optical image from the optical system 11. The CCD image sensor 12 can read all pixels. More specifically, all pixels are read on a frame basis in an interlaced scanning CCD. The interlaced scanning and frame reading generates a 2-field signal. This signal corresponds to an image which is exposed at the same time by the mechanical shutter in the optical system 11.

An image pickup signal generated from the CCD image sensor 12 is supplied to a front end circuit 13. The front end circuit 13 comprises a CDS (correlation double sampling) circuit, a GCA (gain control amplifier), an A/D (analog/digital) converter, and the like for detecting each pixel's electric charge which is photoelectrically converted and stored in the CCD. An output signal from the front end circuit 13 is sent to a delay circuit 20 via a memory control circuit 14. Memory 15 is connected to the memory control circuit 14. The memory 15 is used for rearranging the frame-read signal from the CCD image sensor 12 according to spatial array data on the CCD.

The CCD image sensor 12 is supplied with a read pulse signal from a timing

generator 16. The front end circuit 13 is supplied with a sampling pulse, an A/D converter drive pulse, and the like from the timing generator 16. The timing generator 16 is supplied with a control signal from a system control circuit 17. A delay circuit 120 is also supplied with a control signal from the system control circuit 17.

The following describes the frame read operation from the CCD image sensor 12 and the rearrangement in the memory 15 with reference to FIGS. 8 to 10. FIG. 8 illustrates frame reading on the CCD image sensor 12. This operation reads all pixels on all lines N0 to N5. Since interlaced scanning is performed every other line, a CCD output signal is read as a 2-field signal as shown in FIG. 9. This signal comprises a first field F1 for even-numbered lines N0, N2, and N4, and a second field F2 for odd-numbered lines N1, N3, and N5. The memory control circuit 14 controls to write or read a signal for two fields F1 and F2 from memory 15. As shown in FIG. 10, this signal is arranged for output in the order of spatial arrays on the CCD. The output signal from the memory control circuit 14 in FIG. 10 becomes a frame image signal which follows the order of lines N0 to N5 on the CCD.

Again in FIG. 6, an output signal from the delay circuit 20 is sent to a Y (brightness) process circuit 40 and a C (chromaticness) process circuit 60 via a preprocessing circuit 30. A control signal from the system control circuit 17 is also supplied to the Y process circuit 40 and the C process circuit 60.

FIG. 7 shows part of a configuration associated with the chromaticness signal processing which is a major function for the embodiment of the present invention. In

this FIG. 7, the delay circuit 20 retrieves a no-delay signal [H0D] and 1H delay signal [H1D] to 5H delay signal [H5D], and sends these signals to a preprocessing circuit 30 using five 1H (one horizontal interval or one line) delay devices 21 to 25. With regard to correspondence among these signals [H0D] to [H5D] and lines N0 to N5 in FIG. 10, for example, the no-delay signal [H0D] corresponds to line N5. The 1H delay signal [H1D], the 2H delay signal [H2D], ... and the 5H delay signal [H5D] correspond to the line N4, the line N3, ... and the line N0, respectively.

In the preprocessing circuit 30, the signals [H0D] to [H5D] are added as follows. An adder 31 adds signals [H0D] to [H1D]. An adder 32 adds signals [H2D] to [H3D]. An adder 33 adds signals [H4D] to [H5D]. An adder 34 adds output from the adder 31 to output from the adder 33. A 1/2 multiplier 35 halves output from the adder 34. The preprocessing circuit 30 sends an output signal  $([H0D]+[H1D]+[H4D]+[H5D])/2$  from the multiplier 35 and an output signal  $([H2D]+[H3D])$  from the adder 32 to a Y process circuit 40. An output signal  $([H2D]+[H3D])$  from the adder 32 is to be processed currently. The signals [H0D] to [H5D] are sent to a synthesizer circuit 38 via a horizontal spatial phase synchronization filter 36 and a vertical spatial phase synchronization filter 37. Signals S1r/S2r and S1b/S2b from the synthesizer circuit 38 are sent to a C process circuit 60. The horizontal spatial phase synchronization filter 36 uses the following tap factors for filter operations.

$$(1,0,3)/(3,0,1)$$

The vertical spatial phase synchronization filter 37 uses the following tap factors for filter operations.

$$(1,0,4,0,3,0)/(0,3,0,4,0,1)$$

Synthesis processing in the synthesizer circuit 38 means creating signals S1r, S2r, S1b, and S2b based on complementary data (Cy, Ye, G, Mg) whose horizontal and vertical spatial phases are synchronized. The signals S1r, S2r, S1b, and S2b are expressed as follows.

$$S1r = Cy + G, \quad S2r = Ye + Mg$$

$$S1b = Cy + Mg, \quad S2b = Ye + G$$

The process circuit 60 directly sends signals S1r/S2r and S1b/S2b from the synthesizer circuit 38 to a postprocessing circuit 62, thereby bypassing a horizontal spatial phase synchronization filter 61. This is because the preprocessing circuit 30 already synchronizes horizontal spatial phases, eliminating the need for processing by a horizontal spatial phase synchronization filter 61 in the existing C process circuit 60.

The following describes in more detail operations in the preprocessing circuit 30 which provides a main function for chromaticness signal processing according to this configuration. The horizontal spatial phase synchronization filter 36 and the vertical spatial phase synchronization filter 37 synchronize spatial phases as follows. For example, a signal is formatted according to a pixel array on the CCD as shown in FIG. 10. This example shows that a region Q contains four pixels Cy22, Ye23, Mg32, and G33. Point p is a center for these pixels. An interpolation operation is performed

to find data (pixel values) for these complementary colors Cy, Ye, Mg, and G instead of these pixels Cy22, Ye23, Mg32, and G33.

In order to explain the example, it is assumed that  $V_p$  is a vertical spatial phase and  $H_p$  is a horizontal spatial phase of the point  $p$  for synchronizing the spatial phases. Each pixel has a subscript such as say "23" in  $Ye23$ . In this example, "2" represents a vertical phase and "3" represents a horizontal phase. Each pixel data at the point  $p$  can be expressed as  $CyVpHp$ ,  $YeVpHp$ ,  $MgVpHp$ , and  $GVpHp$ . The example in FIG. 10 assumes  $V_p=2.5$  and  $H_p=2.5$ . As an example, the following describes how to find  $CyVpHp$  using an interpolation or filter operation. In this case, the horizontal spatial phase synchronization filter 36 is first used to find pixel data  $Cy0Hp$ ,  $Cy2Hp$ , and  $Cy4Hp$  having the horizontal phase  $H_p=2.5$ . These pixel data can be found by performing the following filter operations using tap factors (3, 0, 1).

$$Cy0Hp = 3*Cy02 + 0*Ye03 + 1*Cy04$$

$$Cy2Hp = 3*Cy22 + 0*Ye23 + 1*Cy24$$

$$Cy4Hp = 3*Cy42 + 0*Ye43 + 1*Cy44$$

Generally, operations with tap factor 0 are omitted as follows.

$$Cy0Hp = 3*Cy02 + 1*Cy04$$

$$Cy2Hp = 3*Cy22 + 1*Cy24$$

$$Cy4Hp = 3*Cy42 + 1*Cy44$$

The same applies to the following description. The horizontal spatial phase synchronization filter 36 uses the same tap factors (3, 0, 1) for Mg. However, tap

factors (1, 0, 3) are used for Ye and G.

As mentioned above, the horizontal spatial phase synchronization filter 36 synchronizes horizontal spatial phases in pixel data such as Cy0Hp, Cy2Hp, and Cy4Hp.

This pixel data is sent to the vertical spatial phase synchronization filter 37 which then synchronizes vertical spatial phases in the pixel data.

The following filter operation uses tap factors (1, 0, 4, 0, 3, 0) to find pixel data having the vertical phase  $V_p=2.5$  such as CyVpHp.

$$CyVpHp = 1*Cy0Hp + 4*Cy2Hp + 3*Cy4Hp$$

The tap factors (1, 0, 4, 0, 3, 0) are used for finding YeVpHp. However, the tap factors (0, 3, 0, 4, 0, 1) are used for finding MgVpHp and GVpHp.

As mentioned above, horizontal and vertical spatial phases are synchronized for pixel data CyVpHp, YeVpHp, MgVpHp, and GVpHp. The synthesizer circuit 38 then performs the following operations using data for these complementary colors Cy, Ye, Mg, and G of the pixel data.

$$S1r = Cy + G, S2r = Ye + Mg$$

$$S1b = Cy + Mg, S2b = Ye + G$$

These operations create signals S1r, S2r, S1b, and S2b. These signals are sent to the postprocessing circuit 62 in the C process circuit 60.

Signals S1r, S2r, S1b, and S2b from the synthesizer circuit 38 are created according to an array of 2 x 2 pixels on the CCD. Given that "fsv" signifies a sampling

frequency in the vertical direction, no false color occurs at (1/4) fsv.

The present invention is not limited to the above-mentioned embodiment. While the embodiment describes an application to the video camera apparatus, the present invention can be applied to other image pickup apparatuses. While the embodiment explains signal processing by means of a frame read operation using the interlaced scanning CCD, the present invention can be applied to a system which can read data for each discrete line in a complementary mosaic color coding CCD. The pixel array for complementary mosaic color coding is not limited to the embodiment. Other arrays are also available. The present invention can be applied to the use of a color coding filter for three primary colors. It is further understood by those skilled in the art that various changes and modifications may be made in the invention without departing from the spirit and scope thereof.

WHAT IS CLAIMED IS:

1. An image pickup apparatus comprising:
  - an image pickup element having a color coding filter;
  - spatial phase synchronization means for synchronizing horizontal and vertical spatial phases based on output from each line in the image pickup element; and
  - synthesis means for generating a synthesized signal based on a signal whose horizontal and vertical spatial phases are synchronized in the spatial phase synchronization means, wherein a signal from the synthesis means is subject to chromaticness processing.
2. An image pickup apparatus according to claim 1, wherein the color coding filter is a complementary mosaic color coding filter.
3. An image pickup apparatus according to claim 2, wherein the complementary mosaic color coding filter is based on a repetition of two pixels horizontally by four lines vertically, and
  - wherein the filter comprises:
    - a first line which is an alternate repetition of Cy (cyan) and Ye (yellow);
    - a second line which is an alternate repetition of G (green) and Mg (magenta);
    - a third line which is an alternate repetition of Cy and Ye; and
    - a fourth line which is an alternate repetition of Mg and G.
4. An image pickup apparatus according to claim 2, wherein the synthesis means generates new signals S1r, S2r, S1b, and S2b by

performing the following operations:

$$S1r = Cy + G, \quad S2r = Ye + Mg$$

$$S1b = Cy + Mg, \quad S2b = Ye + G$$

based on Cy (cyan), Ye (yellow), G (green), and Mg (magenta) of each pixel data in a signal whose horizontal and vertical spatial phases are synchronized in the spatial phase synchronization means.

5. An image pickup apparatus according to claim 1,

wherein the image pickup element is read on a frame basis by independently scanning odd-numbered and even-numbered lines.

6. An image pickup method for an image pickup apparatus provided with an image pickup element having a color coding filter,

wherein the image pickup method comprises:

the step of allowing spatial phase synchronization means to synchronize horizontal and vertical spatial phases based on output from each line in the image pickup element;

the step of allowing synthesis means to create a synthesized signal based on a signal whose horizontal and vertical spatial phases are synchronized in the spatial phase synchronization means; and

the step of performing chromaticness processing for a signal from the synthesis means.

7. An image pickup method according to claim 6,

wherein the color coding filter is a complementary mosaic color coding filter.

8. An image pickup method according to claim 7,

wherein the complementary mosaic color coding filter is based on a repetition of two pixels horizontally by four lines vertically, and

wherein the filter comprises:

a first line which is an alternate repetition of Cy (cyan) and Ye (yellow);

a second line which is an alternate repetition of G (green) and Mg (magenta);

a third line which is an alternate repetition of Cy and Ye; and

a fourth line which is an alternate repetition of Mg and G.

9. An image pickup method according to claim 7,

wherein the synthesis means generates new signals S1r, S2r, S1b, and S2b by performing the following operations:

$$S1r = Cy + G, \quad S2r = Ye + Mg$$

$$S1b = Cy + Mg, \quad S2b = Ye + G$$

based on Cy (cyan), Ye (yellow), G (green), and Mg (magenta) of each pixel data in a signal whose horizontal and vertical spatial phases are synchronized in the spatial phase synchronization means.

10. An image pickup method according to claim 6,

wherein the image pickup element is read on a frame basis by independently scanning odd-numbered and even-numbered lines.

## ABSTRACT OF THE DISCLOSURE

A system according to the present invention reads image pickup signals for all lines from a CCD image sensor and inputs these signals to a delay circuit 20. The system retrieves signals [H0D] to [H5D] for six contiguous lines and sends these signals to a vertical spatial phase synchronization filter 37 via a horizontal spatial phase synchronization filter 36. These filters 36 and 37 synchronize horizontal and vertical spatial phases. The system performs the following operations on the basis of Cy (cyan), Ye (yellow), G (green), and Mg (magenta) in each pixel data for the signal whose horizontal and vertical phases are synchronized.

$$S1r = Cy + G, \quad S2r = Ye + Mg$$

$$S1b = Cy + Mg, \quad S2b = Ye + G$$

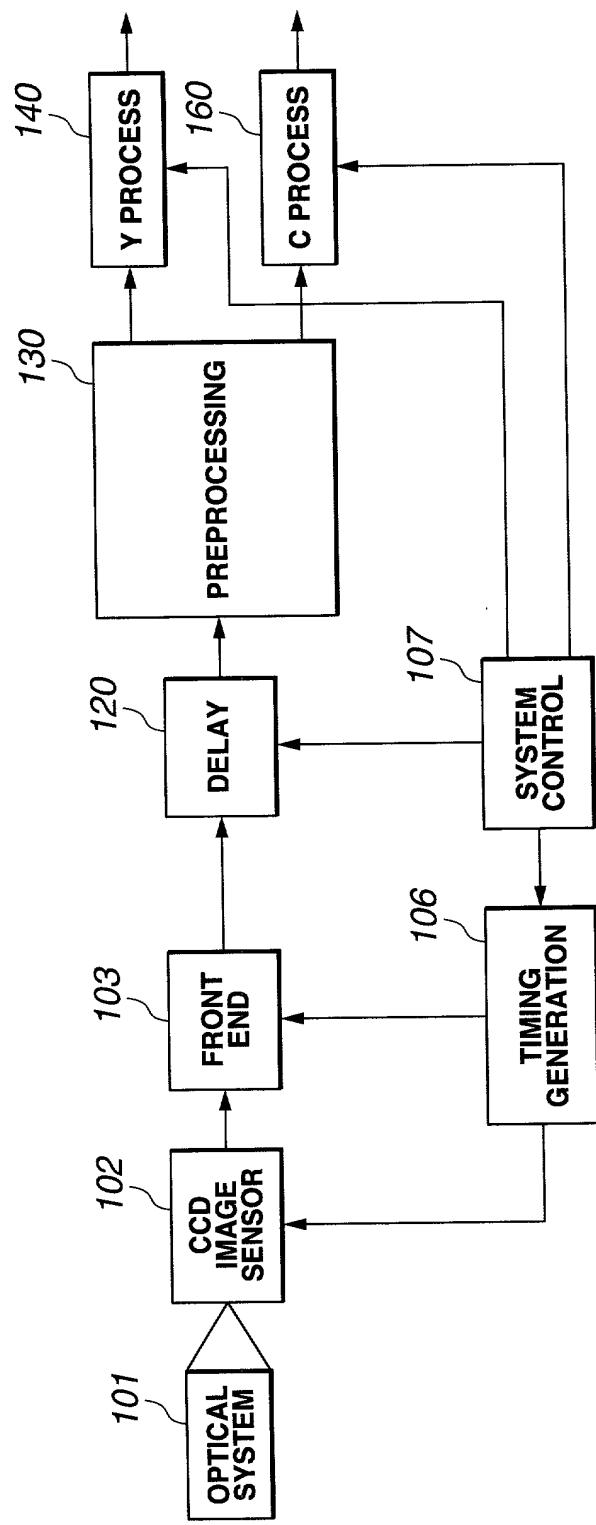
These operations create new signals S1r, S2r, S1b, and S2b which are then sent to a C process circuit 60.

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N0	Cy00	Ye01	Cy02	Ye03	Cy04	Ye05
N1	G10	Mg11	G12	Mg13	G14	Mg15
N2	Cy20	Ye21	Cy22	Ye23	Cy24	Ye25
N3	Mg30	G31	Mg32	G33	Mg34	G35
N4	Cy40	Ye41	Cy42	Ye43	Cy44	Ye45
N5	G50	Mg51	G52	Mg53	G54	Mg55

**FIG.1**

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**FIG.2**

N0	Cy00	Ye01	Cy02	Ye03	Cy04	Ye05
N1	G10	Mg11	G12	Mg13	G14	Mg15
N2	Cy20	Ye21	Cy22	Ye23	Cy24	Ye25
N3	Mg30	G31	Mg32	G33	Mg34	G35
N4	Cy40	Ye41	Cy42	Ye43	Cy44	Ye45
N5	G50	Mg51	G52	Mg53	G54	Mg55

**FIG.3**

N0 + N1	S1r Cy00 +G10	S2r Ye01 +Mg11	S1r Cy02 +G12	S2r Ye03 +Mg13	S1r Cy04 +G14	S2r Ye05 +Mg15
N2 + N3	S1b Cy20 +Mg30	S2b Ye21 +G31	S1b Cy22 +Mg32	S2b Ye23 +G33	S1b Cy24 +Mg34	S2b Ye25 +G35
N4 + N5	S1r Cy40 +G50	S2r Ye41 +Mg51	S1r Cy42 +G52	S2r Ye43 +Mg53	S1r Cy44 +G54	S2r Ye45 +Mg55

**FIG.4**

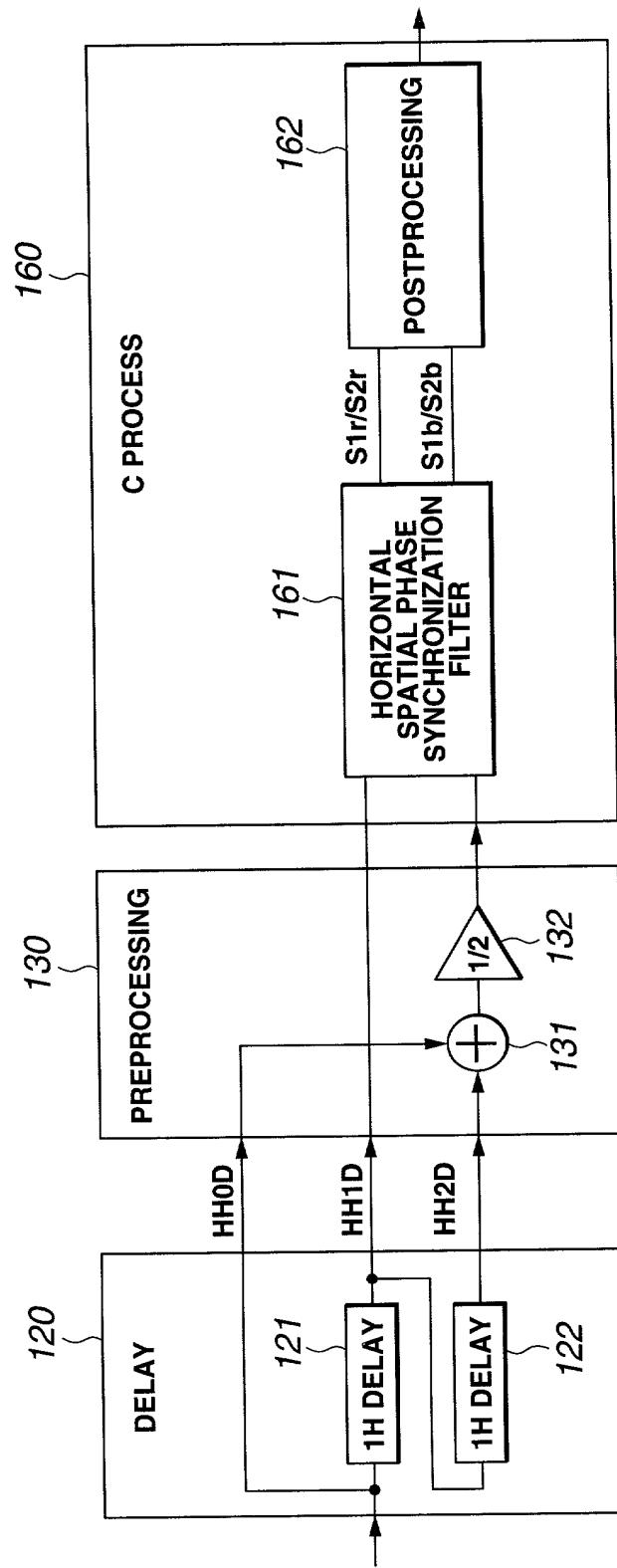


FIG.5

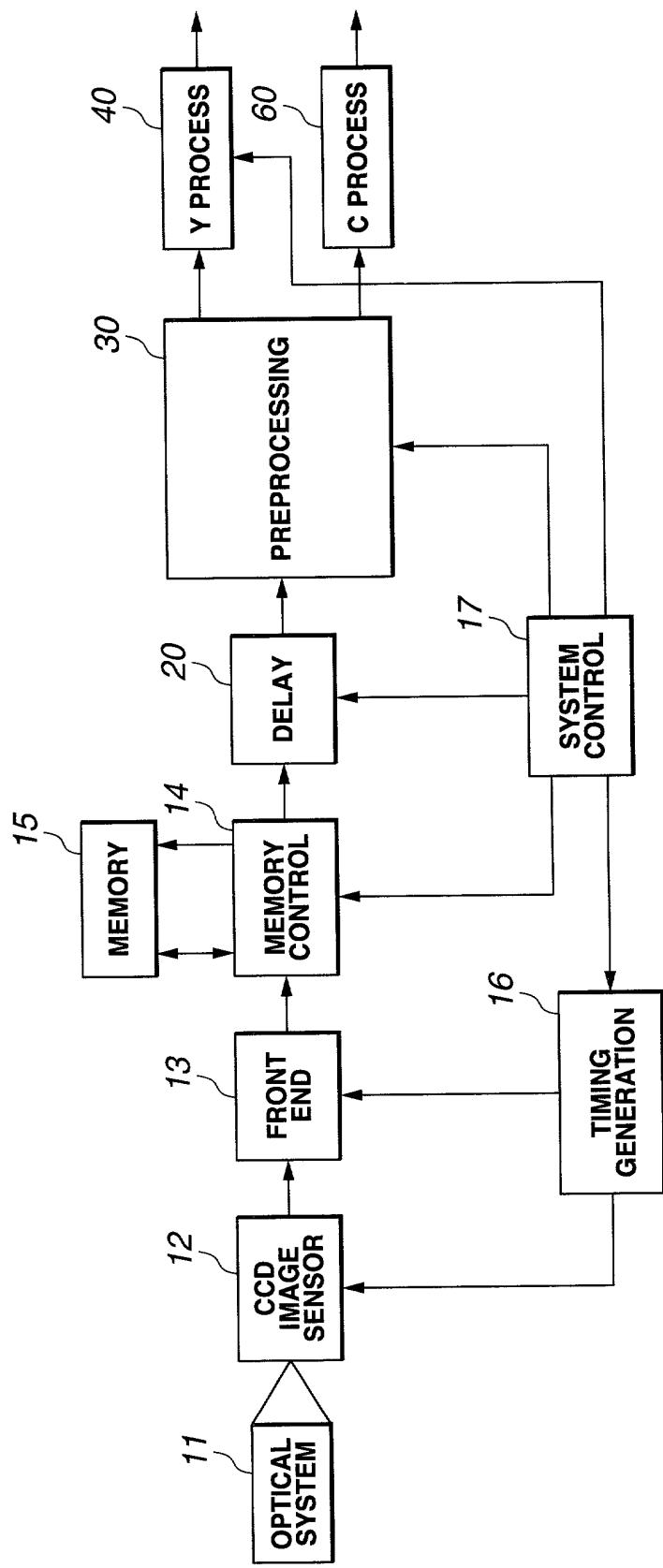


FIG.6

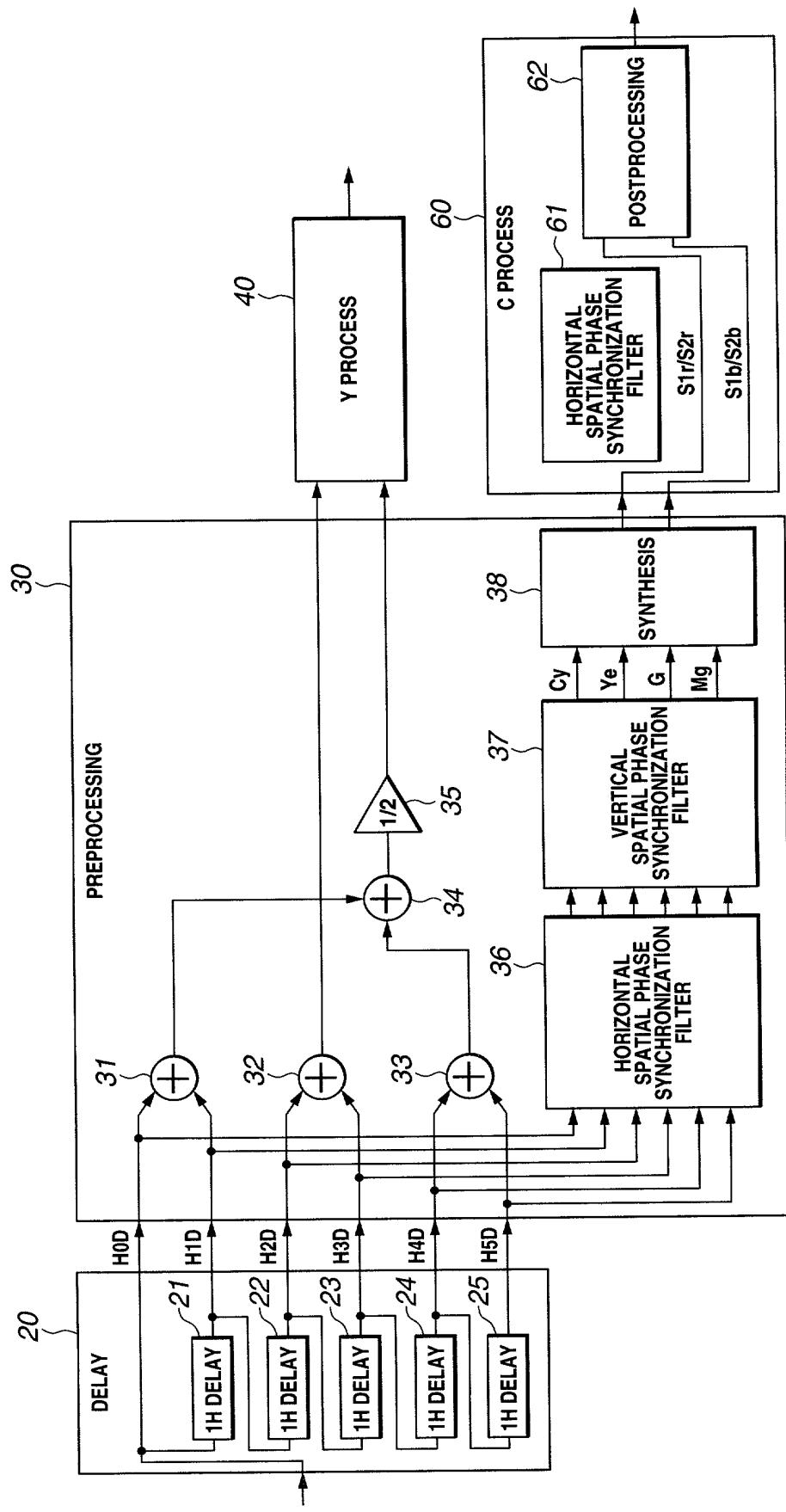
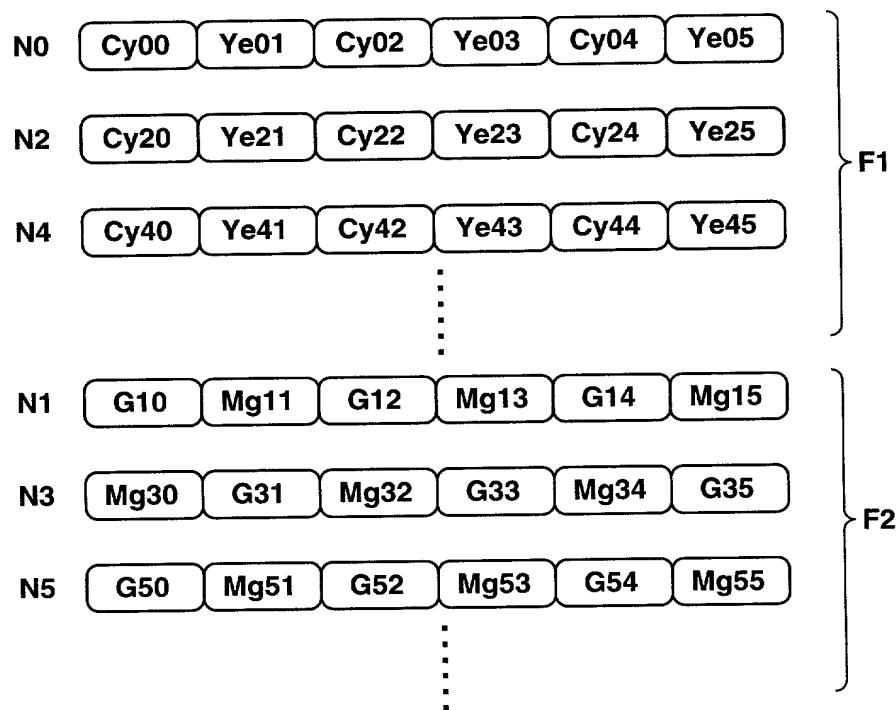


FIG. 7

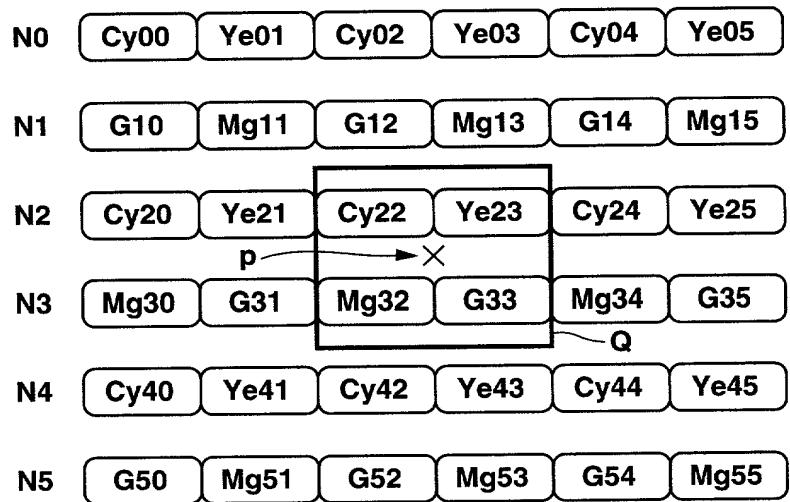
N0	Cy00	Ye01	Cy02	Ye03	Cy04	Ye05
N1	G10	Mg11	G12	Mg13	G14	Mg15
N2	Cy20	Ye21	Cy22	Ye23	Cy24	Ye25
N3	Mg30	G31	Mg32	G33	Mg34	G35
N4	Cy40	Ye41	Cy42	Ye43	Cy44	Ye45
N5	G50	Mg51	G52	Mg53	G54	Mg55

**FIG.8**

0965304E-096530C0



**FIG.9**



**FIG.10**

DECLARATION FOR PATENT APPLICATION (JOINT OR SOLE)

(Under 37 CFR § 1.63; with Power of Attorney)

FROMMERM LAWRENCE &amp; HAUG LLP

FLH File No.: 450100-02700

As a below named inventor, I hereby declare that: .

My residence, post office address and citizenship are as stated below next to my name,

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention ENTITLED:

IMAGE PICKUP APPARATUS AND IMAGE PICKUP METHOD

the specification of which

is attached hereto.

was filed on \_\_\_\_\_ as Application Serial No. \_\_\_\_\_,

with amendment(s) through \_\_\_\_\_ (if applicable, give dates).

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose to the United States Patent and Trademark Office all information known to me to be material to patentability as defined in Title 37, Code of Federal Regulations, Sec. 1.56.

I hereby claim foreign priority benefits under Title 35, United States Code, § 119 of any foreign application(s) for patent or inventor's certificate listed below and have also identified below any foreign application for patent or inventor's certificate having a filing date before that of the application on which priority is claimed:

Prior Foreign Application(s) [list additional applications on separate page]: Priority Claimed:

Number: \_\_\_\_\_ Country: \_\_\_\_\_ Filed (Day/Month/Year): \_\_\_\_\_ Yes \_\_\_\_\_ No \_\_\_\_\_

P11-258101 Japan

10/09/1999

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I hereby claim the benefit under Title 35, United States Code, § 120 of any United States application(s) listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States application in the manner provided by the first paragraph of Title 35, United States Code § 112, I acknowledge the duty to disclose to the United States Patent and Trademark Office all information known to me to be material to patentability as defined in Title 37, Code of Federal Regulations, Sec. 1.56, which became available between the filing date of the prior application and the national or PCT international filing date of this application:

Prior U.S. Application(s) [list additional applications on separate page]:

Appln. Ser. Number: \_\_\_\_\_ Filed (Day/Month/Year): \_\_\_\_\_ Status (patented, pending, abandoned): \_\_\_\_\_

I hereby appoint WILLIAM S. FROMMER, Registration No. 25,506, or his duly appointed associate, my attorneys, with full power of substitution and revocation, to prosecute this application, to make alterations and amendments therein, to file continuation and divisional applications thereof, to receive the Patent, and to transact all business in the Patent and Trademark Office and in the Courts in connection therewith, and specify that all communications about the application are to be directed to the following correspondence address:WILLIAM S. FROMMER, Esq.  
c/o FROMMER LAWRENCE & HAUG LLP  
745 Fifth Avenue  
New York, New York 10151Direct all telephone calls to:  
(212) 588-0800  
to the attention of:  
WILLIAM S. FROMMER

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

INVENTOR(S):

Takayuki NakajimaDate: August 7, 2000

Signature: \_\_\_\_\_

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Residence:

Citizenship:

Signature: \_\_\_\_\_

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Signature: \_\_\_\_\_

Date: \_\_\_\_\_

Full name of 3rd joint inventor (if any):

Residence:

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Note: In order to qualify for reduced fees available to Small Entities, each inventor and any other individual or entity having rights to the invention must also sign an appropriate separate "Verified Statement (Declaration) Claiming [or Supporting a Claim by Another for] Small Entity Status" form [e.g. for Independent Inventor, Small Business Concern, Nonprofit Organization, individual Non-Inventor].

Note: A post office address must be provided for each inventor.